

LOCALIZED DROMION SOLUTION USING PAINLEVE TRUNCATION APPROACH

MYVIZHI.P¹, R. VELAVAN²

¹Assistant Professor, ²Professor, Dept. of Physics, ²Department of Bioinformatics,

¹BIST, BIHER, Bharath university, Chennai-73,

myvizhi.phy@bharathuniv.ac.in

ABSTRACT

Using the methodology of Painleve Truncation Approach (PTA), an infinite integrable non linear dynamical system named long dispersive wave equation (2LDW) has been solved and localized dromion solution is obtained from generalized periodic solution.

KEYWORDS:

Dromions, velocity potentials, localized solutions.

INTRODUCTION

The identification of dromions [1-6] has triggered a renewed interest in the study of integrable models in (2+1) dimensions. Dromions arise essentially by virtue of coupling the field variable to a mean field / potential, thereby preventing wave collapse in (2+1) dimensions and they can, in general undergo inelastic collision unlike one dimensional solitons. The identification of a large number of arbitrary functions in the solutions of (2+1) dimensional integrable models has only added to the richness in the structure of them and hence construction of localized excitations in (2+1) dimensions continues to be a challenging and rewarding contemporary problem. In this equation we developed a very simple and straight forward procedure to generate a rather extended class of generic solutions of physical interest. In this 2LDW equation we utilize the local Laurent expansion of the general solution and truncate it at the constant level term (painleve truncation approach) and obtain solutions in terms of arbitrary functions. Through this procedure we generate various periodic and exponentially localized solutions. The novelty here is that the solution is generated through a simple procedure. But the solution obtained is rich in structure because of the arbitrary functions [9-14].

DROMIONS

Dromions which originate at the crosspoint of the intersection of two nonparallel ghost solitons decay exponentially in all directions and are driven by lower dimensional boundaries or velocity potentials (arbitrary functions) in the system. It must be mentioned that the presence of these so called boundaries enriches the structure of (2 +1) dimensional integrable models leading to the formation of localized solutions like dromions [15-21]

PAINLEVE TRUNCATION APPROACH

Painleve truncation approach is a methodology in which we are going to prove that the (2+1) dimensional long dispersive wave equation is a completely integrable infinite dimensional nonlinear dynamical system[22-29].

The recent interest in the investigation of integrable models in (2+1) dimensions can be attributed to the identification of dromions in the Davey-Stewartson I equation [3]. These dromions which originate at the cross point of the intersection of two nonparallel ghost solitons decay exponentially in all directions and are driven by lower dimensional boundaries or velocity potentials (arbitrary functions) in the system. It must be mentioned that the presence of these so called boundaries enriches the structure of (2+1) dimensional integrable models leading to the formation of localized solutions like dromions, positions, etc. [5]. Thus a judicious harnessing of these lower dimensional arbitrary functions [30-38] of space and time may give rise to new spatio-temporal patterns in higher dimensions besides throwing more light on their integrability.

In this way, a simple procedure is used to solve the (2+1) dimensional system namely Painleve Truncation Approach (PTA) [5]. This approach converts the given evolution equation into a multi linear equation in terms of non characteristic manifold. This multi linear equation can be solved in terms of lower dimensional arbitrary functions of space and time. Using this approach one can generate various generalized periodic and localized solutions. Through PTA (2+1) dimensional equation can be trilinearized. A four parameter special class of solutions involving three arbitrary functions in the variables naturally arises for this **trilinear** equation. Thus, there exists a possibility of obtaining more general solutions[39-43].

Thus, there exists a possibility of obtaining more general solutions.

After solving the physical system such as 2LDW equation,

Considering the long dispersive wave equation (2LDW) [15,16]

$$\lambda_{qt} + q_{xx} - 2_{qv} = 0 \quad (1a)$$

$$\lambda_{rt} - r_{xx} + 2_{rv} = 0 \quad (1b)$$

$$(qr)_x = V_\eta \quad (1c)$$

the trilinear equation obtained is as follows.

$$V_{1\eta} = \Phi_{x\eta}^2 + (\Phi_x \Phi_{x\eta\eta} / \Phi_\eta) - (\Phi_x \Phi_{x\eta} \Phi_{\eta\eta} / \Phi_\eta^2) - (\Phi_{xx\eta} \Phi_{x\eta}^2 \Phi_\eta) + \Phi_x \Phi_{x\eta\eta} \Phi_\eta - \Phi_x \Phi_{x\eta} \Phi_{\eta\eta} - \Phi_\eta^2 \Phi_{xx\eta} = 0 \quad (2)$$

NOVEL EXACT SOLUTIONS OF 2LDW EQUATION

Now we can make use of the truncated Laurent expansion solution to obtain exact solutions of the 2LDW equation (1) for the variables $q(x, \eta, t)$ and $V(x, \eta, t)$. Taking into account our notation in equation (1). From the results, we find that the solution of the original variable takes the form

$$q = [F_1(\eta)F_2(t) (\Phi_{1x}^{\frac{1}{2}}) / \Phi_1(x, t) + \Phi_{21}(\eta) + \Phi_{22}(t)] * e^{\int -1/2\lambda(\Phi_1 t + \Phi_{22}, t) / \Phi_1 dx} \quad (3)$$

The form of $V(x, \eta, t)$ remains the same as given in truncated Laurent expansion with the above general form of the solutions, we now identify interesting classes of exact solutions to the original equation including periodic and localized solutions by giving specific forms for the three arbitrary functions $\Phi_1(x, t)$, $\Phi_{21}(\eta)$, $\Phi_{22}(t)$

A. Periodic solution and localized dromion solution

Let us now choose the arbitrary functions Φ_1 and $F_{1\eta}$ and F_{2t} to be Jacobian elliptic functions namely sn or cn functions. The motivation behind this choice of arbitrary functions stems from the fact that the limiting forms of these functions happen to be localized functions [44-49]. Hence a choice of sn or cn functions can yield periodic solutions

which are more general than exponentially localized solutions (dromions). We choose for example

$$\Phi_1(x, t) = n_1 + \text{sn}(ax + b\eta + c; m_1), \quad (4a)$$

$$\Phi_{21}(\eta) = \text{sn}(d\eta; m_2), \quad (4b)$$

$$\Phi_{22}(t) = \text{sn}(lt; m_3), \quad (4c)$$

$$F_1(\eta) = \text{cn}(g\eta; m_4) \quad (4d)$$

$$F_2(t) = \text{cn}(ht; m_5) \quad (4e)$$

$$q(x, \eta, t) =$$

$$\frac{[\text{cn}(g\eta; m_4)\text{cn}(ht; m_5)][\sqrt{\text{acn}(u_1; m_1)\text{dn}(u_1; m_1)}]}{(n_1 + \text{sn}(u_1; m_1) + \text{sn}(d\eta; m_2) + \text{sn}(lt; m_3))} \quad (4f)$$

where $u_1 = (ax + b\eta + c)$.

In (4f) the quantities m_1 and m_2 are the modulus parameters of the respective Jacobian elliptic functions while a, b and c are arbitrary constants. The corresponding expression for

$|s(x, \eta, t)|^2$ takes the form

$$|q|^2 = \frac{[\text{cn}(g\eta; m_4)\text{cn}(ht; m_5)]^2 [\text{acn}(u_1; m_1)\text{dn}(u_1; m_1)]}{[4 + \text{sn}(d\eta; m_2) + \text{sn}(lt; m_3)]^2} \quad (4g)$$

B. (1,1)dromion solution

As a limiting case of the periodic solution (27a) when m_1, m_2, m_3, m_4 and m_5 tends to 1, the above solution degenerates into an exponentially localized solution(dromion). Noting that

$$\text{cn}(u; 1) = \text{dn}(u; 1) = \text{sech} u \text{ and } \text{sn}(u; 1) = \tanh u,$$

the limiting forms corresponding to (1,1) dromion takes the expressions

$$|q|^2 = [\text{asech}(g\eta) \text{sech}(ht) \text{sech}^2(ax + b\eta + c)] / |n_1 + \tanh(ax + by + c) + \tanh(d\eta) + \tanh(lt)|^2$$

A schematic form of (1,1) dromion for the parametric choice $a=2, b=3, c=1$ is shown in figure 4.3.2(b). Again note that the dromion travels with a unit velocity in a diagonal direction in the x-y plane.

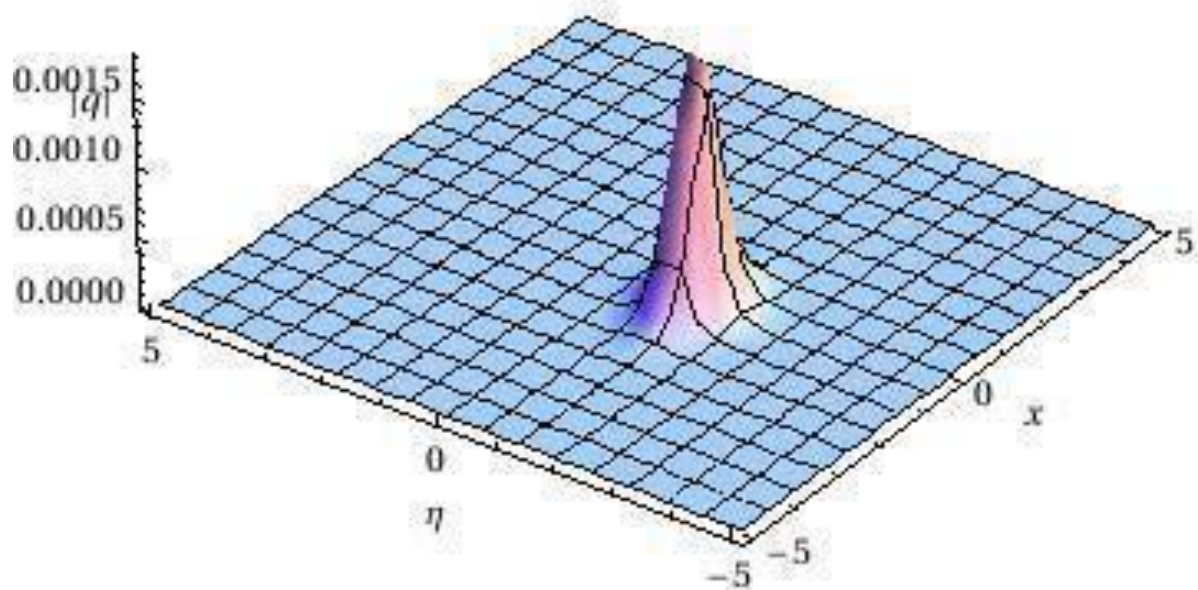


Figure 4.3.2 (b) - Localized Dromion Solution

CONCLUSION

In this paper, I has taken the $(2+1)$ dimensional long dispersive wave equation which is solved already in terms of the arbitrary functions using the **Painleve Truncation Approach (PTA)** method. More general elliptic function solution such as limiting form of $(1,1)$ **dromion** is generated from the trilinear equation. It will enrich the existence of lower dimensional arbitrary functions, which will help us further to construct further higher dromion solutions.

ACKNOWLEDGEMENT:

I am very thankful to honorable chairman Pro-chancellor, Vice Chancellor, Registrar, Dean R&D and Dean Engineering of Bharath University for their continuous support and encouragement given to carry out this research work

REFERENCES

1. Lakshmanan M and Rajasekar S. Nonlinear Dynamics Integrability, Chaos and Patterns 2003
2. Boiti M. Leon J J P, Martina L and Pempinelli F. Scattering of localized solitons in the plane. 1988 Phys. Lett. A 132:432-9.
3. Fokas A S and Santini P M. Dromions and a boundary value problem for the Davey-Stewartson I equation. Physica D 1990, 44:99-130
4. Konopelchenko B G 1993 Solitons in Multidimensions (Singapore: World Scientific)
5. Radha R, Senthil kumar C, Lakshmanan M, Tang X Y, Lou S Y. Periodic and localized solutions of the long wave-short wave resonance interaction equation. *J. Phys A* 2005;38:9649-63.
6. Ramamoorthy, R., Kanagasabai, V., Kausalya, R., Impact of celebrities' image on brand, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-251-253, 2017
7. Ramamoorthy, R., Kanagasabai, V., Vignesh, M., Quality assurance in operation theatre with reference to fortis malar hospital, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-87-93, 2017
8. Ramya, N., Arthy, J., Honey comb graphs and its energy, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-83-86, 2017
9. Ramya, N., Jagadeeswari, P., Proper coloring of regular graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-531-533, 2017
10. Ramya, N., Karunagaran, K., Proper, star and acyclic coloring of some graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-43-44, 2017

11. Ramya, N., Muthukumar, M., On coloring of 4-regular graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-491-494, 2017
12. Ramya, N., Muthukumar, M., On star and acyclic coloring of graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-467-469, 2017
13. Ramya, N., Pavi, J., Coloring of book and gear graphs, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-401-402, 2017
14. Ramya, P., Hameed Hussain, J., Alteration framework for integrating quality of service in internet real-time network, International Journal of Pure and Applied Mathematics, V-116, I-8 Special Issue, PP-57-61, 2017
15. Ramya, P., Sriram, M., Tweet sarcasm: Peep, International Journal of Pure and Applied Mathematics, V-116, I-10 Special Issue, PP-231-235, 2017
16. Sabarish, R., Meenakshi, C.M., Comparision of beryllium and CI connecting rod using ansys, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-127-132, 2017
17. Sabarish, R., Rakesh, N.L., Outcome of inserts for enhancing the heat exchangers, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-419-422, 2017
18. Sangeetha, M., Gokul, N., Aruls, S., Estimator for control logic in high level synthesis, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-425-428, 2017
19. Sangeetha, M., Gokul, N., Aruls, S., Image steganography using a curvelet transformation, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-417-422, 2017
20. Saraswathi, P., Srinivasan, V., Peter, M., Research on financial supply chain from view of stability, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-211-213, 2017
21. Saravana Kumar, A., Hameed Hussain, J., Expanding the pass percentage in semester examination, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-45-48, 2017
22. Saravana, S., Arulselvi, S., AdaBoost SVM based brain tumour image segmentation and classification, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-399-403, 2017
23. Saravana, S., Arulselvi, S., Dynamic power management monitoring and controlling system using wireless sensor network, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-405-408, 2017
24. Saravana, S., Arulselvi, S., Clustered morphic algorithm based medical image analysis, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-411-415, 2017
25. Saravana, S., Arulselvi, S., Networks, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-393-396, 2017
26. Saritha, B., Chockalingam, M.P., Adsorptive removal of heavy metal chromium from aqueous medium using modified natural adsorbent, International Journal of Civil Engineering and Technology, V-8, I-8, PP-1382-1387, 2017

27. Saritha, B., Chockalingam, M.P., Adsorptive removal of brilliant green dye by modified coconut shell adsorbent, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-211-215, 2017
28. Saritha, B., Chockalingam, M.P., Photodegradation of eriochrome black-T dye from aqueous medium by photocatalysis, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-183-187, 2017
29. Saritha, B., Chockalingam, M.P., Photodegradation of malachite green DYE using TiO₂/activated carbon composite, International Journal of Civil Engineering and Technology, V-8, I-8, PP-156-163, 2017
30. Saritha, B., Chockalingam, M.P., Synthesis of photocatalytic composite Fe-C/TiO₂ for degradation of malachite green dye from aqueous medium, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-177-181, 2017
31. Saritha, B., Chockalingam, M.P., Removal of heavy metal from aqueous medium using modified natural adsorbent, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-205-210, 2017
32. Saritha, B., Chockalingam, M.P., Degradation of malachite green dye using a semiconductor composite, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-195-199, 2017
33. Saritha, B., Chockalingam, M.P., Photocatalytic decolourisation of textile industry wastewater by TiO₂, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-221-224, 2017
34. Saritha, B., Chockalingam, M.P., Study on photocatalytic degradation of Crystal Violet dye using a semiconductor, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-209-212, 2017
35. Shanthi, E., Nalini, C., Rama, A., The effect of highly-available epistemologies on hardware and architecture, International Journal of Pharmacy and Technology, V-8, I-3, PP-17082-17086, 2016
36. Shanthi, E., Nalini, C., Rama, A., Drith: Autonomous, random communication, International Journal of Pharmacy and Technology, V-8, I-3, PP-17002-17006, 2016
37. Shanthi, E., Nalini, C., Rama, A., A case for replication, International Journal of Pharmacy and Technology, V-8, I-3, PP-17234-17238, 2016
38. Shanthi, E., Nalini, C., Rama, A., Elve: A methodology for the emulation of robots, International Journal of Pharmacy and Technology, V-8, I-3, PP-17182-17187, 2016
39. Shanthi, E., Nalini, C., Rama, A., Autonomous epistemologies for 802.11 mesh networks, International Journal of Pharmacy and Technology, V-8, I-3, PP-17087-17093, 2016
40. Sharavanan, R., Golden Renjith, R.J., Design and analysis of fuel flow in bend pipes, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-59-64, 2017
41. Sharavanan, R., Jose Ananth Vino, V., Emission analysis of C.I engine run by diesel, sunflower oil, 2 ethyl hexyl nitrate blends, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-403-408, 2017

42. Sharavanan, R., Sabarish, R., Design of built-in hydraulic jack for light motor vehicles, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-457-460, 2017
43. Sharavanan, R., Sabarish, R., Design and fabrication of aqua silencer using charcoal and lime stone, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-513-516, 2017
44. Sharmila, G., Thooyamani, K.P., Kausalya, R., A schoolwork on customer relationship management with special reference to domain 2 host, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-199-203, 2017
45. Sharmila, S., Jeyanthi Rebecca, L., Anbuselvi, S., Kowsalya, E., Kripanand, N.R., Tanty, D.S., Choudhary, P., Swathy Priya, L., GC-MS analysis of biofuel extracted from marine algae, Der Pharmacia Lettre, V-8, I-3, PP-204-214, 2016
46. Sidharth Raj, R.S., Sangeetha, M., Data embedding method using adaptive pixel pair matching method, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-417-421, 2017
47. Sidharth Raj, R.S., Sangeetha, M., Android based industrial fault monitoring, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-423-427, 2017
48. Sidharth Raj, R.S., Sangeetha, M., Mobile robot system control through an brain computer interface, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-413-415, 2017
49. Sivaraman, K., Sundarraj, B., Decisive lesion detection in digital fundus image, International Journal of Pure and Applied Mathematics, V-116, I-10 Special Issue, PP-161-164, 2017
50. Sridhar, J., Sriram, M., Cloud privacy preserving for dynamic groups, International Journal of Pure and Applied Mathematics, V-116, I-8 Special Issue, PP-117-120, 2017

